SB761
U757
#84-14

United States
Department of
Agriculture
**Forest
Service**
Southwestern
Region

Forest Pest Management Report

R-3 84-14

WESTERN SPRUCE BUDWORM
SUPPRESSION PROJECT--1983

Carson National Forest
New Mexico

July 1984

LIBRARY
AUG - 9 1984
ROCKY MOUNTAIN STATION

3440

R-3 84-14

WESTERN SPRUCE BUDWORM SUPPRESSION PROJECT--1983

Carson National Forest
New Mexico

July 1984

Prepared By

William G. Telfer and James P. Linnane

USDA Forest Service, Southwestern Region
State and Private Forestry
Forest Pest Management
517 Gold Avenue, SW
Albuquerque, New Mexico 87102

CONTENTS

	Page
ABSTRACT	1
INTRODUCTION	1
OBJECTIVES	1
PROJECT ORGANIZATIONAL STRUCTURE	2
INSECTICIDES	2
SPRAY BLOCKS	2
TIMING OF SPRAY APPLICATION	3
WEATHER	3
APPLICATION	4
SPRAY DEPOSIT ASSESSMENT	4
ENVIRONMENTAL MONITORING	5
EVALUATING PROJECT EFFECTIVENESS	5
PROJECT COSTS	6
CONCLUSIONS	7
LITERATURE CITED	7
APPENDIXES	7a

ABSTRACT

Carbaryl and Bacillus thuringiensis were applied on 37,587 acres of mixed conifer stands on the El Rito and Tres Piedras Ranger Districts, Carson National Forest, where western spruce budworm, Choristoneura occidentalis Free., population levels were just reaching outbreak levels. Bacillus thuringiensis was applied to sensitive and riparian areas. Postspray population levels averaged 3.1 larvae per 100 buds on the carbaryl areas. Spray project location, organization, methods, and results are discussed.

INTRODUCTION

A suppression project against the western spruce budworm (WSBW), Choristoneura occidentalis Free., was conducted on the Carson National Forest (NF) during June and July 1983. This report documents objectives, methods, and results of this suppression project.

WSBW-caused defoliation increased from 81,760 acres in 1976 to 114,450 acres in 1982 on the Carson NF and adjacent lands. Significant amounts of defoliation were adjacent to the 1982 suppression project areas. Based on an environmental analysis,[1] additional direct suppression was determined to be necessary in infested areas adjacent to the 1982 suppression project.

Plans were made to aerially treat approximately 35,000 acres with insecticides. Treatment areas were selected based on the strategy of suppressing early stage infestations (1 to 3 years of visible defoliation) adjacent to the 1982 suppression project, thus increasing the length of suppression for both 1982 and 1983 projects. Based on this strategy, 35,607 acres were treated with carbaryl and 1,980 acres were treated with Bacillus thuringiensis (B.t.) on the Tres Piedras and El Rito Ranger Districts.

OBJECTIVES

Objectives were to:

1. Reduce WSBW populations to as low a level as possible so that predators and parasites, in conjunction with density independent factors, such as weather, exert considerable population regulation.

2. Keep tree damages below economic levels.

---

[1] The Record of Decision for the Western Spruce Budworm Management Plan, Final Environmental Impact Statement, Carson National Forest, dated October 27, 1981.

3. Prevent spread of WSBW infestations onto adjacent uninfested lands.

4. Prevent severe defoliation.

PROJECT ORGANIZATIONAL STRUCTURE

The project team consisted of personnel from the Carson NF and Forest Pest Management, State and Private Forestry, Southwestern Region. Figure 1 shows the organizational structure.

INSECTICIDES

Carbaryl (Sevin 4 oil[2]) was applied at 0.25 gallons per acre (1 pound active ingredient). The Sevin 4 oil was diluted with an equal amount of diesel, for a total volume per acre of 0.5 gallons. Carbaryl has proven effectiveness against the WSBW in the Southwest.

B.t. (Thuricide 32 LV[3]) was applied at 12 billion international units per acre. The Thuricide was diluted with an equal amount of water, for a total volume per acre of 0.75 gallons. B.t. has been extensively tested against the WSBW with varying success. A 1981 pilot test in New Mexico produced satisfactory results leading to the decision to use B.t. operationally (Ragenovich 1983).

The insecticide strategy was to treat sensitive and riparian areas with B.t. and treat the remaining areas with carbaryl.

Background information on both carbaryl and B.t., including environmental hazards, can be found in Appendix B, Draft Environmental Impact Statement, Carson National Forest, dated February 20, 1981.

SPRAY BLOCKS

The treatment area was divided into spray blocks (figure 2). Blocks were designed to make foliage and larval development as uniform as possible, have access for population sampling, and have good identifiable boundaries.

---

[2] Union Carbide Corporation trade name for carbaryl insecticide; 4 pounds active ingredient per gallon.
[3] Zoecon Corporation trade name.

Names and estimated gross acreages of the spray blocks were as follows:

	Spray block	Acreage[4]
1.	Broke Off Mountain	7,000
2.	Cisneros Park	8,000
3.	Valle Grande	6,500
4.	La Jara	10,500
5.	B.t. areas	2,000
		33,500

TIMING OF SPRAY APPLICATION

For maximum efficiency, carbaryl was applied when 20 percent of the budworm population were in the fifth instar. B.t. was applied when 50 percent of the budworm population were in the fourth instar. To determine larval development, sampling began on June 8, 1983, and continued until June 20, 1983.

Developmental sampling consisted of cutting one 15-inch apical, mid-crown branch from an open grown, 30- to 60-foot tall, Douglas-fir at each of 15 developmental sample plots on each spray block. All larvae from the branch and pole pruner bag were removed and placed in alcohol in the field. Larval instars were determined in the laboratory. The average percentage of the WSBW population in each instar was computed for each sampling date and each spray block.

WEATHER

Local weather forecasts were provided each day to the project director. These forecasts were obtained by the project meteorologist from the National Weather Service (NWS) office in Albuquerque, New Mexico. The project meteorologist collected early morning local weather data in the spray blocks and transmitted this data to the NWS and the project director. From this information, the NWS made next day spot forecasts, including precipation probability, wind conditions, relative humidity, and temperature gradients in the spray area.

---

[4] The actual acreage treated differs slightly due to the availability of insecticides and spray block surface area. Table 1 displays actual acreage treated.

Spray operations commenced if the chance for precipation was 20 percent or less (20% equates to widely scattered afternoon showers) and winds on spray block were less than 8 miles per hour. Spray operations ceased when winds exceeded 8 to 10 miles per hour or the temperature exceeded 68° F on the spray block.

APPLICATION

The insecticides were applied using fixed-wing aircraft. Calibration and characterization trials were conducted subsequent to the start of spray operations. Pressure nozzles equipped with 8020 flat fan tips (Spraying Systems Corporation) and attached to an airfoil boom were the delivery system. The aircraft were equipped with wind-driven pumps.

The volume median diameter (VMD), as determined using the D-Max method (Maksymuik 1963), was 180 to 200 microns for Sevin 4 oil, and 150 to 170 microns for Thuricide 32 LV. This VMD was obtained flying at a ground speed of 150 miles per hour, with the nozzle orientation 45° down and back for Sevin and straight down for Thuricide. The swath width was estimated at 150 feet for both materials.

Three spray aircraft were used to apply the insecticides. The aircraft were all Air Tractor 400's, with a 400-gallon hopper capacity and operated by Chuck's Spraying Service, Bovina, Texas. These aircraft were powered by Pratt and Whitney turbine engines.

Two observation helicopters, a Bell 206 and a Hughes 500D, were used to direct spraying operations. Observers in these helicopters directly supervised spray operations. Helicopters were oriented at both ends of a spray swath and served as a "flag" for the lead aircraft of the three aircraft spray formation. Aerial observers kept spray aircraft within treatment block boundaries, adjusted swath overlap, and assured shut off of spraying over sensitive areas.

Spraying carbaryl began on June 22, 1983, and continued until July 1, 1983. B.t. spraying was done on July 2, 1983. Table 1 shows the acres and spray blocks sprayed for each spray day.

SPRAY DEPOSIT ASSESSMENT

A spray deposition assessment was undertaken, principally, to determine if sampling points were treated. Carbaryl deposition was estimated using Sudan black cards. In the morning just prior to spraying, two cards were placed in a clearing near each cluster plot. If possible, cards were placed at least one tree height in distance from all trees so as not to be in the spray shadow of any tree. Fifty cards were placed on each spray block. Plastic cardholders developed by the Missoula Equipment Development Center were used.

Cards were collected after spraying. Using a template, the number of spray droplets within a 4 square centimeter area was estimated. The mean number of spray droplets per square centimeter per card was then calculated. Deposition was considered acceptable if droplet densities equaled or exceeded 10 drops per cm^2.

The average droplet density for individual treatment blocks was as follows:

Broke Off Mountain	-	4.3 drops/cm^2
Valle Grande	-	9.1 drops/cm^2
Cisneros Park	-	12.9 drops/cm^2
La Jara	-	13.9 drops/cm^2

No spray assessment of B.t. was performed.

ENVIRONMENTAL MONITORING

The U.S. Fish and Wildlife Service conducted an aquatic invertebrate monitoring on the Canada Tio Grande, Rio Nutritas, and Rio Vallecitos. In addition, Bobcat Creek, accidently receiving carbaryl drift as part of the 1982 Carson Western Spruce Budworm Suppression Project, was reevaluated.[5]

Data collected during these surveys indicated no carbaryl-related mortality occurred to invertebrate populations in streams sampled in 1983. The 1983 data collected form Bobcat Creek indicated that insect populations occurred at levels at least equal to that observed during the 1982 surveys.

EVALUATING PROJECT EFFECTIVENESS

Effectiveness of the pesticide treatments was evaluated by measuring larval mortality of the 1982-83 budworm generation. Larval mortality was determined by sampling the budworm population on each spray block 1 day prior to spraying and 10 days after spraying.

Sampling design consisted of 15 prespray and 25 postspray plots on each spray block. Each plot consisted of a three-tree cluster of Douglas-fir trees. The three trees were located within 1 acre. One branch was sampled per tree. This design was based upon a study done by Schmid (1984).

---

[5]Report on file with USDA Forest Service, Forest Pest Management, Regional Office, Southwestern Region.

The plot constituted the primary sampling unit. Plot means were computed by averaging larvae per 100 buds for each tree sampled, and then averaging the 3 trees. Larval means and standard errors were calculated for each spray block. Sampling was performed in the usual manner and is described in detail on page 87, Parker et al. (1978).

Mean unadjusted budworm mortality for the project, excluding the B.t. areas, was 86 percent. Unadjusted mortality ranged from 66 to 96 percent. Excluding the B.t. areas, the project postspray average number of larvae per 100 buds was 3.1, with a range of 0.3 to 7.6. Prespray and postspray mean larval densities and percent mortality for each spray block are presented in table 2. The appendix contains the mean number of larvae per 100 buds for each cluster plot for prespray and postspray samples on each spray block.

PROJECT COSTS

Total project cost was $271,341. A breakdown of expenses follows:

Insecticides	Item cost	Total cost
Carbaryl	$131,293	
Diesel fuel	9,400	
B.t	7,513	
Sticker	500	
		$148,706
Application		
Contractor	36,934	
Helicopters	24,335	
Reconnaissance	364	
		61,633
Supplies		450
Security		15,453
Overhead: salaries, overtime, and travel		
Carson National Forest	20,072	
Forest Pest Management	17,450	
		37,522
Environmental monitoring, U.S. Fish and Wildlife Service		7,100
Miscellaneous costs		477
	Total project cost	271,341

Treatment cost per acre treated was $7.22.

CONCLUSIONS

Control ranged from good to excellent on the spray blocks, with the exception of the La Jara spray block. Spray deposit was acceptable on the La Jara block. Mortality may have been reduced by locally heavy rainfall on June 27 and 28. One area of the Valle Grande block had visible defoliation detected during an aerial survey in August (figure 2). This area may have been sprayed while the foliage was still wet. Shortly after spraying, there was a wind. The dew and carbaryl were probably shaken off the trees, resulting in poor control. Control on the Broke Off Mountain block was excellent; however, spray deposit (4.3 drops/cm^2) was poor. There is no simple explanation for this anomaly.

Overall, the project met the objectives, except on portions of the La Jara spray block which had high postspray larval populations.

LITERATURE CITED

Ragenovich, I. R. 1983. Pilot project to evaluate the operational use of Bacillus thuringiensis against the western spruce budworm in northern New Mexico--1981-82, Carson National Forest and State and private land, New Mexico. Progress Rep. No. 1. USDA Forest Serv., Southwestern Region. R-3 84-1. 62 pp.

Maksymuik, B. 1963. How to estimate the atomization of oil-base aerial sprays by the D-Max method. Forest Service Research Note WO-1. USDA Forest Serv., Washington D.C. 6 pp.

Schmid, J. M. 1984. Larval densities, mortality, and sampling at different canopy levels during an insecticide project. J. Econ. Entomol. (In press.)

Parker, D. L., R. E. Acciavatti, and E. D. Lessard. 1978. Western spruce budworm suppression and evaluation project using carbaryl, 1977. Progress Report No. 1. USDA Forest Service, Southwestern Region. R-3 78-11. 136 pp.

APPENDIXES

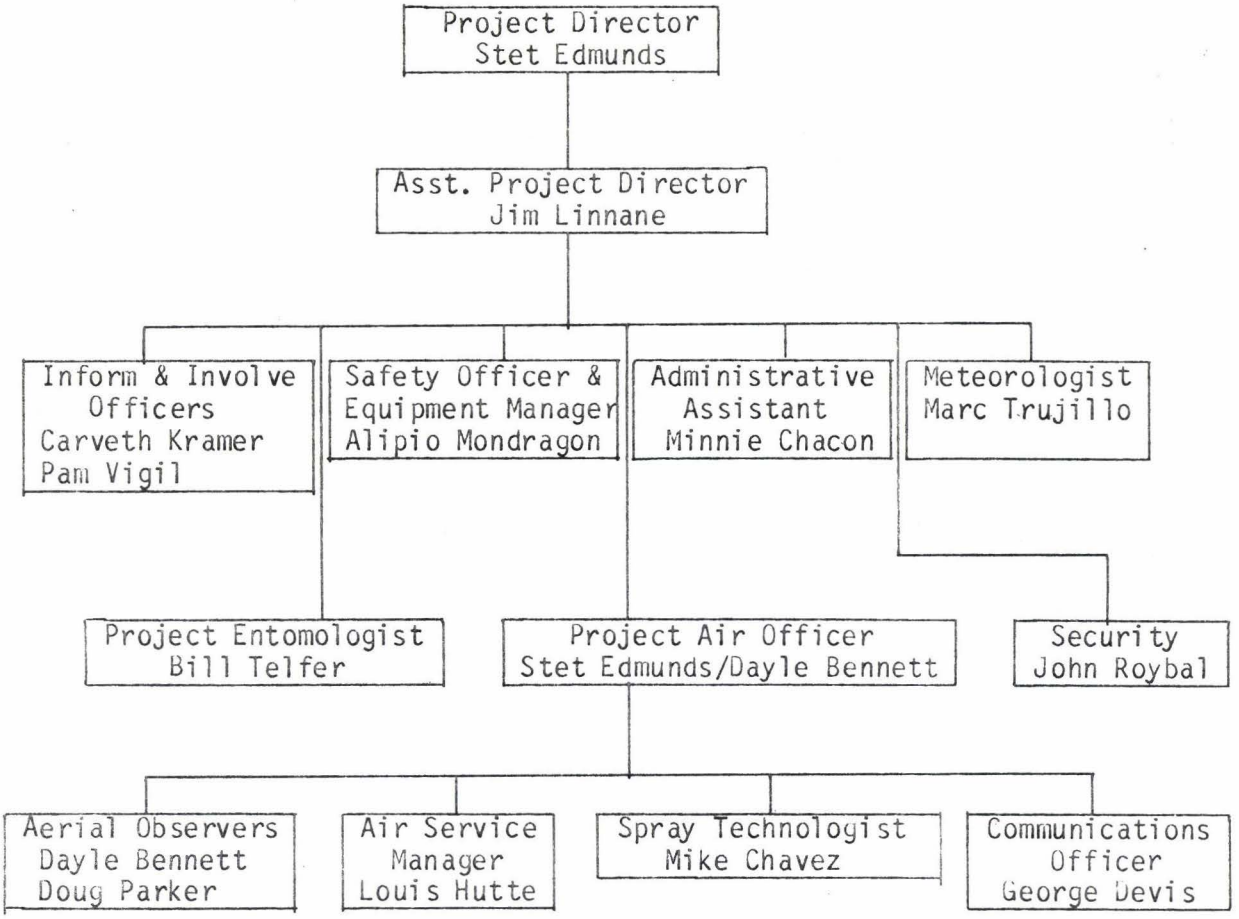
TABLE 1.--Spray dates and acres treated with carbaryl and *Bacillus thuringiensis* (*B.t.*), Carson National Forest, 1983 western spruce budworm suppression project

Date of application	Spray block	Pesticide	Acres treated
June 22	La Jara	Carbaryl	3,405
June 23	La Jara and Valle Grande	Carbaryl	5,540
June 24	Valle Grande and Cisneros Park	Carbaryl	3,662
June 27	Valle Grande	Carbaryl	3,048
June 28	Valle Grande and Cisneros Park	Carbaryl	7,330
June 29	Cisneros Park	Carbaryl	5,588
June 30	Cisneros Park, Valle Grande, and re-treatment of some of 1982 missed areas	Carbaryl	4,182
July 1	Broke Off Mountain	Carbaryl	2,852
		Total carbaryl acres	35,607
July 1	Tusas and Vallecitos River valleys	*B.t.*	1,254
July 2	Tusas and Vallecitos River valleys	*B.t.*	726
		Total *B.t.* acres	1,980

TABLE 2.--Mean larvae per 100 buds for prespray and postspray samples and percent mortality (unadjusted), Carson National Forest, 1983 western spruce budworm suppression project

Spray block	Larvae per 100 buds		Percent unadjusted mortality
	Prespray	Postspray	
Broke Off Mountain	$\bar{x}$ = 25.30 SE = 7.17	$\bar{x}$ = 0.96 SE = 0.47	96.2
Valle Grande	$\bar{x}$ = 20.78 SE = 2.72	$\bar{x}$ = 2.94 SE = 0.65	85.6
Cisneros Park	$\bar{x}$ = 17.64 SE = 2.10	$\bar{x}$ = 0.72 SE = 0.30	95.9
La Jara	$\bar{x}$ = 22.45 SE = 2.60	$\bar{x}$ = 7.33 SE = 1.22	67.4
B.t. (n=3)	$\bar{x}$ = 19.42 SE = 4.97	$\bar{x}$ = 4.4 SE = 1.8	77.3

FIGURE 1.--Carson National Forest, 1983 western spruce budworm suppression project organization chart



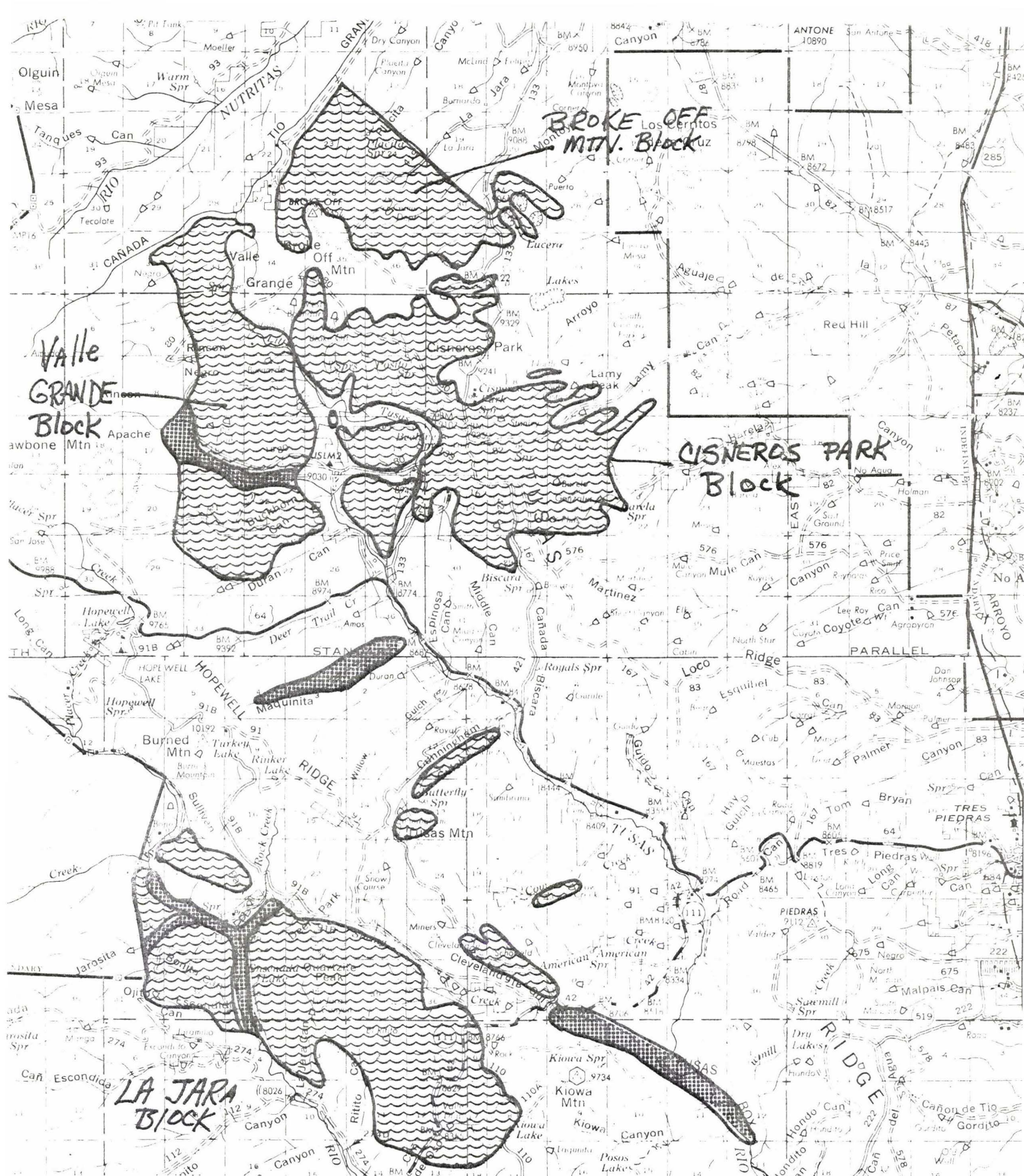


FIGURE 2.--Location of spray blocks, Carson National Forest, western spruce budworm suppression project, 1983

APPENDIX

Prespray and Postspray Larval Sampling Data

Mean number of larvae per 100 buds for each cluster plot for prespray and postspray samples for each spray block

PRESPRAY

Spray block	Cluster plot	Larvae	Pupae	Cases	Total
Broke Off Mtn	104	149.84	0.00	0.00	149.84
	110	53.76	0.00	0.00	53.76
	113	54.43	0.00	0.00	54.43
	116	15.97	0.00	0.00	15.97
	122	19.75	0.00	0.00	19.75
	125	12.70	0.00	0.00	12.70
	131	6.26	0.00	0.00	6.26
	134	16.48	0.00	0.00	16.48
	137	12.57	0.00	0.00	12.57
	143	21.23	0.00	0.00	21.23
	149	5.09	0.00	0.00	5.09
	155	11.86	0.00	0.00	11.86
	161	23.31	0.00	0.00	23.31
	167	10.12	0.00	0.00	10.12
	173	9.44	0.00	0.00	9.44
Valle Grande	201	13.14	0.00	0.00	13.14
	207	9.88	0.00	0.00	9.88
	213	8.22	0.00	0.00	8.22
	219	28.70	0.00	0.00	28.70
	225	15.62	0.00	0.00	15.62
	231	11.16	0.00	0.00	11.16
	237	15.52	0.00	0.00	15.52
	246	32.78	0.00	0.00	32.78
	252	33.19	0.00	0.00	33.19
	255	24.48	0.00	0.00	24.48
	258	27.70	0.00	0.00	27.70
	264	8.91	0.00	0.00	8.91
	267	13.29	0.00	0.00	13.29
	270	40.61	0.00	0.00	40.61
	273	28.54	0.00	0.00	28.54

Mean number of larvae per 100 buds for each cluster plot for prespray and postspray samples for each spray block--Continued

Spray block	Cluster plot	Larvae	Pupae	Cases	Total
Cisneros Park	301	11.82	0.00	0.00	11.82
	307	13.66	0.00	0.00	13.66
	313	13.95	0.00	0.00	13.95
	319	11.90	0.00	0.00	11.90
	325	16.87	0.00	0.00	16.87
	328	31.95	0.00	0.00	31.95
	331	25.94	0.00	0.00	25.94
	337	33.40	0.00	0.00	33.40
	340	17.53	0.00	0.00	17.53
	343	16.00	0.00	0.00	16.00
	355	18.58	0.00	0.00	18.58
	358	22.59	0.00	0.00	22.59
	364	10.56	0.00	0.00	10.56
	370	17.29	0.00	0.00	17.29
	373	2.54	0.00	0.00	2.54
La Jara	401	22.19	0.00	0.00	22.19
	410	30.96	0.00	0.00	30.96
	404	25.56	0.00	0.00	25.56
	416	16.56	0.00	0.00	16.56
	419	7.49	0.00	0.00	7.49
	422	8.46	0.00	0.00	8.46
	428	20.31	0.00	0.00	20.31
	434	15.93	0.00	0.00	15.93
	443	24.65	0.00	0.00	24.65
	446	20.92	0.00	0.00	20.92
	452	6.52	0.00	0.00	6.52
	455	36.90	0.00	0.00	36.90
	461	34.28	0.00	0.00	34.28
	467	33.81	0.00	0.00	33.81
	473	32.09	0.00	0.00	32.09
B.t.	501	19.36	0.00	0.00	19.36
	504	28.06	0.00	0.00	28.06
	507	10.84	0.00	0.00	10.84

Mean number of larvae per 100 buds for each cluster plot for prespray and postspray samples for each spray block--Continued

POSTSPRAY

Spray block	Cluster plot	Larvae	Pupae	Cases	Total
Broke Off Mtn	122	0.00	0.00	0.00	0.00
	119	0.00	0.00	0.00	0.00
	116	3.75	0.00	1.23	4.99
	113	0.00	.67	28.74	.95
	110	.38	0.00	0.00	.38
	107	0.00	1.72	0.00	1.72
	104	0.00	0.00	.56	.56
	101	.36	3.75	.69	4.81
	167	0.00	0.00	0.00	0.00
	164	0.00	0.00	0.00	0.00
	161	0.00	0.00	0.00	0.00
	158	0.00	0.00	0.00	0.00
	155	0.00	0.00	0.00	0.00
	152	0.00	0.00	0.00	0.00
Valle Grande	264	0.00	0.00	0.00	0.00
	258	3.37	0.00	0.00	3.37
	246	2.52	0.00	0.00	2.52
	249	1.27	0.00	0.00	1.27
	252	3.36	0.00	0.00	3.36
	255	2.56	0.00	0.00	2.56
	261	1.47	0.00	0.00	1.47
	267	.31	0.00	0.00	.31
	270	2.35	0.00	0.00	2.35
	273	.67	0.00	0.00	.67
	222	3.90	0.00	0.00	3.90
	225	10.76	0.00	0.00	10.76
	219	14.34	0.00	0.00	10.68
	216	2.56	0.00	0.00	2.56
	213	2.28	0.00	0.00	2.28
	210	0.00	0.00	0.00	0.00
	207	1.70	0.00	0.00	1.70
	204	1.89	0.00	0.00	1.89
	201	.68	0.00	0.00	.68
	228	5.35	0.00	0.00	5.35
	237	1.22	0.00	0.00	1.22
	243	8.33	0.00	0.00	8.33
	240	.43	0.00	0.00	.43

Mean number of larvae per 100 buds for each cluster plot for prespray and postspray samples for each spray block--Continued

Spray block	Cluster plot	Larvae	Pupae	Cases	Total
Cisneros Park	325	.72	0.00	0.00	.72
	316	3.33	0.00	0.00	3.33
	361	0.00	0.00	0.00	0.00
	349	0.00	0.00	0.00	0.00
	355	0.00	0.00	0.00	0.00
	358	0.00	0.00	0.00	0.00
	364	0.00	0.00	0.00	0.00
	313	5.02	0.00	0.00	5.02
	367	0.00	0.00	0.00	0.00
	370	0.00	0.00	0.00	0.00
	373	0.00	0.00	0.00	0.00
	307	0.00	0.00	0.00	0.00
	310	0.00	0.00	0.00	0.00
	319	0.00	0.00	0.00	0.00
	322	0.00	0.00	0.00	0.00
	346	0.00	0.00	0.00	0.00
	304	0.00	0.00	0.00	0.00
	342	.41	0.00	0.00	.41
	340	.33	0.00	0.00	.33
	337	0.00	0.00	0.00	0.00
	334	4.29	.61	0.00	4.90
	331	0.00	0.00	0.00	0.00
	328	0.00	0.00	0.00	0.00
	301	2.67	0.00	0.00	2.67
	352	.54	0.00	0.00	.54
La Jara	458	11.84	0.00	0.00	11.84
	464	10.11	0.00	0.00	10.11
	467	12.02	.65	0.00	12.68
	461	3.06	.45	0.00	3.51
	455	6.22	0.00	0.00	6.22
	470	18.02	.47	0.00	18.49
	473	22.28	0.00	0.00	22.28
	434	8.23	2.23	0.00	10.46
	431	3.57	0.00	0.00	3.57
	428	3.80	0.00	0.00	3.80
	425	2.59	0.00	0.00	2.59
	422	.72	0.00	0.00	.72
	419	2.13	16.77	0.00	18.90
	416	5.79	1.88	0.00	7.66
	413	5.31	0.00	0.00	5.31
	437	6.46	.71	0.00	7.17
	419	11.00	0.00	0.00	11.00
	407	2.41	.24	0.00	2.65
	404	.65	.32	0.00	.97

Mean number of larvae per 100 buds for each cluster plot for prespray and postspray samples for each spray block--Continued

Spray block	Cluster plot	Larvae	Pupae	Cases	Total
	401	.65	0.00	0.00	.65
	452	0.00	0.00	0.00	0.00
	449	4.93	0.00	0.00	4.93
	446	.68	0.00	0.00	.68
	443	7.14	2.38	0.00	9.52
	440	7.59	0.00	0.00	7.59
B.t.	501	1.29	0.00	0.00	1.29
	507	4.34	0.00	0.00	4.34
	504	7.62	0.00	0.00	7.62

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key--out of the reach of children and animals--and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honeybees or other pollinators are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the label.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Trade names and commercial enterprises or products are mentioned solely for necessary information. No endorsement by the U.S. Department of Agriculture is implied.